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TETHERED SATELLITE DESIGN

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PSN

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## SATELLITE CONCEPT

### A) MISSION OBJECTIVES

#### ◦ ENGINEERING TEST

TO TEST THE CAPABILITY OF THE SATELLITE TO PERFORM A VARIETY OF SPACE OPERATIONS TO BE ACCOMPLISHED FROM THE SHUTTLE, CONSIDERING:

- USE OF THE SATELLITE WITH MAN-IN-LOOP AND CLOSED LOOP MODES
- DEPLOYMENT (TOWARD OR AWAY FROM EARTH, UP TO 100 KM), STATIONKEEPING, RETRIEVAL AND CONTROL OF THE SATELLITE.

#### ◦ SCIENTIFIC PAYLOADS

TO PERFORM EXPERIMENTS AND SCIENTIFIC INVESTIGATION FOR APPLICATIONS SUCH AS:

- MAGNETOMETRY
- ELECTRODYNAMICS
- ATMOSPHERIC SCIENCE
- CHEMICAL RELEASE
- COMMUNICATIONS
- PLASMAPHYSICS
- DYNAMIC ENVIRONMENT
- POWER AND THRUST GENERATION

## SATELLITE CONCEPT (CONT'D)

### B) REUSABLE

THE TSS-S WILL BE REUSED FOR AT LEAST 3 MISSIONS AFTER RECONFIGURATION AND REFURBISHMENT BY CHANGING THE PECULIAR MISSION ITEMS: THERMAL CONTROL, FIXED BOOM FOR EXPERIMENTS, AERODYNAMIC TAIL FOR YAW ATTITUDE CONTROL, EXTERNAL SKIN, EXPERIMENTS, ANY OTHER FEATURE

### C) MODULES

THE TSS-S IS COMPOSED OF THREE MODULES IN ORDER TO ALLOW INDEPENDENT INTEGRATION OF A SINGLE MODULE AND TO FACILITATE THE REFURBISHMENT AND RECONFIGURATION BETWEEN THE FLIGHTS.

THE THREE MODULES ARE:

- SERVICE MODULE (SM)
- AUXILIARY PROPULSION MODULE (APM)
- PAYLOAD MODULE (PM)

## SATELLITE CAPABILITY

- PAYLOAD

TOTAL WEIGHT 66 Kg; 2 Kg ON THE FIXED BOOM **1.0** METER LONG (46 Kg FOR ATM MISSION)

2000 WH OF ENERGY

- THREE AXIS ATTITUDE MEASUREMENT

- ATTITUDE AND SPIN CONTROL AROUND YAW AXIS (NO SPIN CONTROL FOR ATM MISSION)

- SPIN VELOCITY MEASUREMENT (N/A TO ATM MISSION)

- COMMUNICATION WITH ORBITER P.I. VIA S-BAND LINK FOR COMMAND RECEPTION AND TELEMETRY DATA TRANSMISSION

## SATELLITE CAPABILITY (CONT'D)

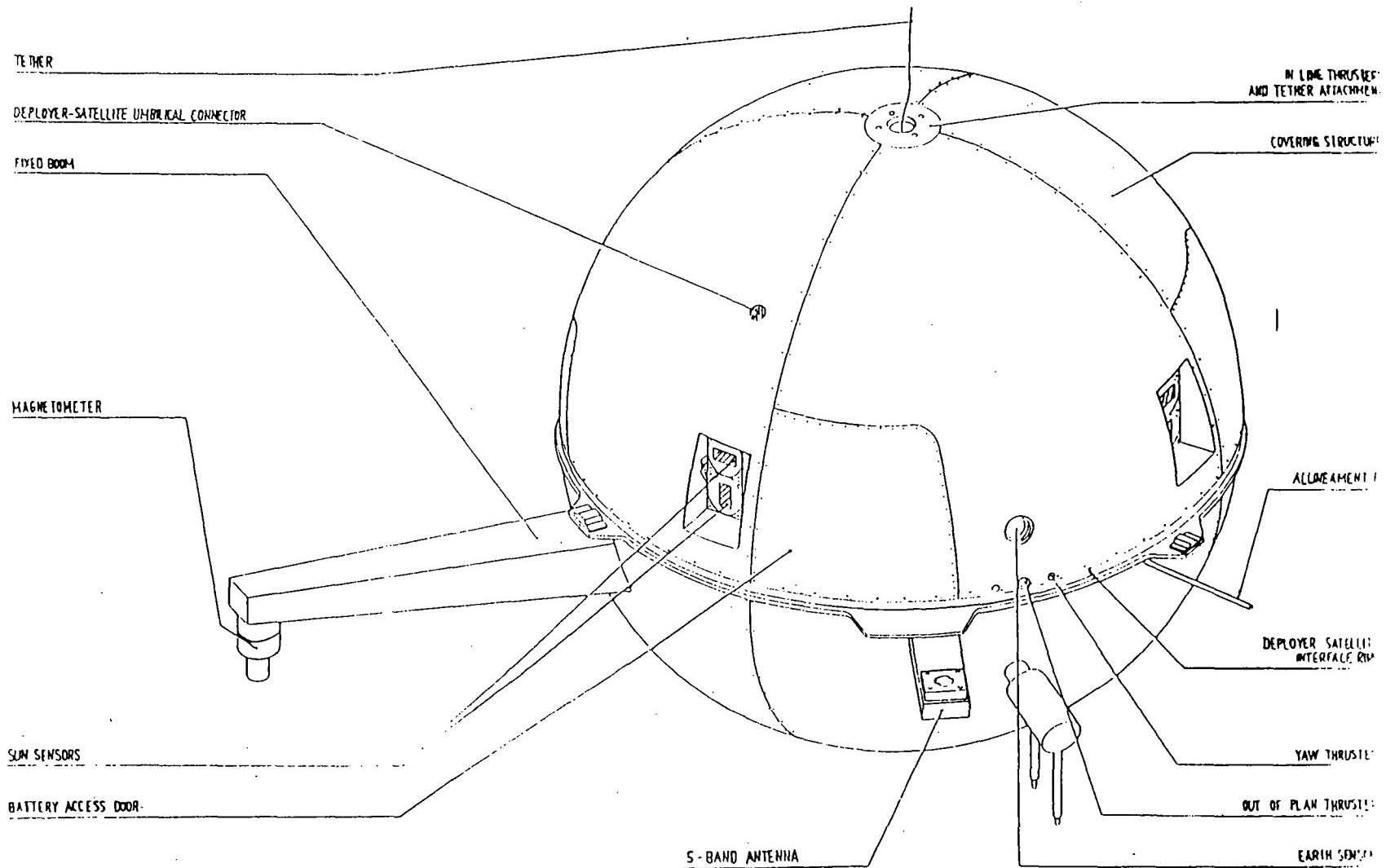
- CONTROL OF SATELLITE FUNCTIONS
  - MONITORS ACQUISITION
  - AMCS DATA PROCESSING
  - COMMAND DISTRIBUTION
- ENGINEERING DATA MONITORING: SATELLITE TEMPERATURES, GN<sub>2</sub> PRESSURE, BATTERIES VOLTAGE, ENERGY AND FUEL CONSUMPTION
- OPERATIONAL SUPPORT TO THE TSS
  - IN LINE THRUSTERS TO AVOID TETHER TENSION LOWER THAN 2N
  - SIDE THRUSTERS FOR IN-PLANE AND OUT-OF-PLANE OSCILLATION DAMPING

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## SATELLITE EXTERNAL CONFIGURATION

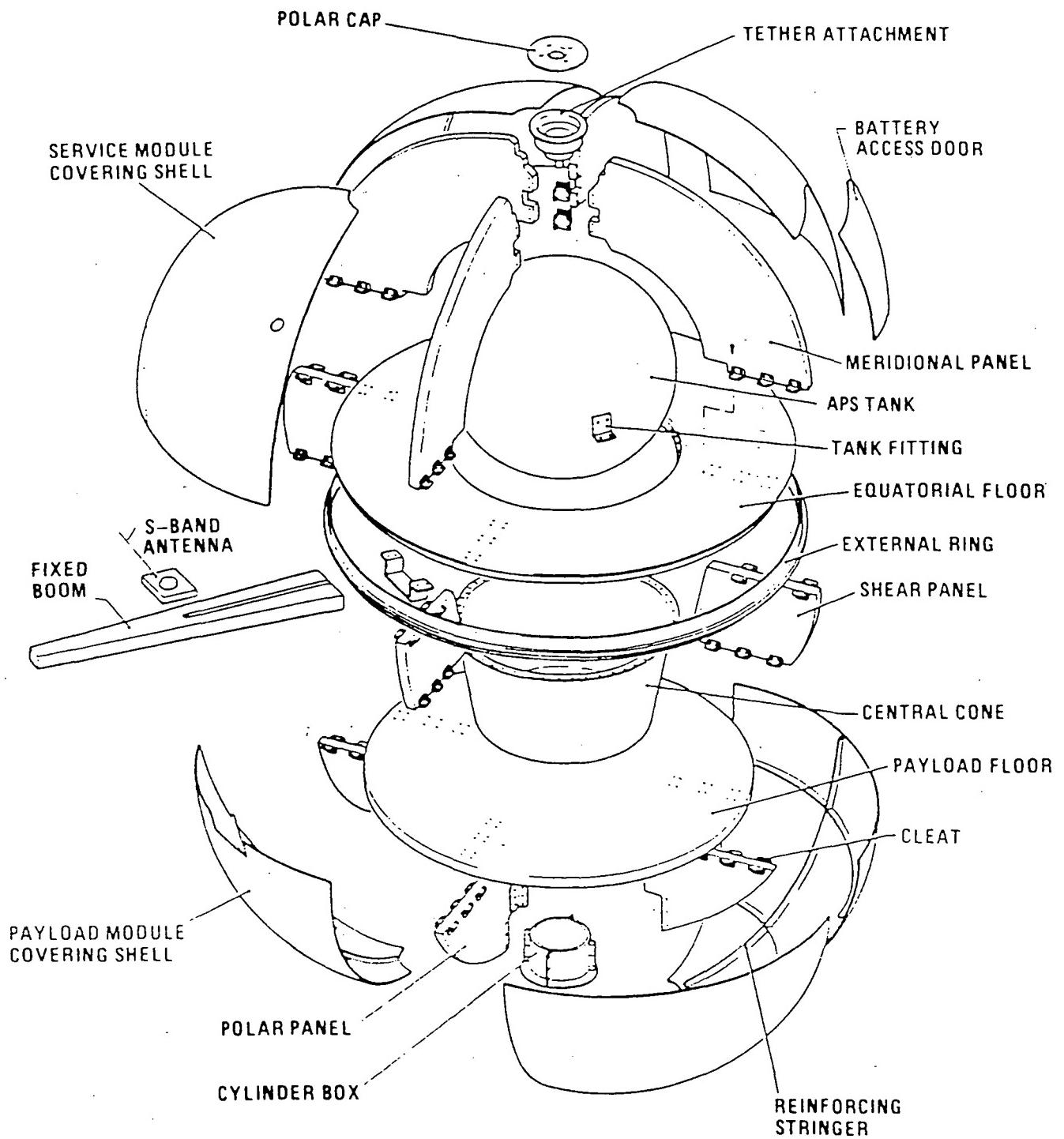
- SPHERICAL, 1.6 METERS DIAMETER
- WEIGHT, 500 Kg INCLUDING EXPERIMENTS
- 8 COVERING PETALS TO ALLOW THE SUBSYSTEMS AND PAYLOAD INTEGRATION/REFURBISHMENT
- 4 ACCESS DOORS FOR BATTERIES INTEGRATION AND CHANGE-OUT
- TETHER ATTACHMENT INTEGRATED IN THE IN-LINE THRUSTERS ASSEMBLY
- EQUATORIAL RING WITH 6 SUPPORTS FOR MECHANICAL INTEGRATION WITH THE DEPLOYER
- 2 SKIN CONNECTORS FOR SATELLITE/DEPLOYER ELECTRICAL CONNECTION PRIOR DEPLOYMENT
- WINDOWS FOR SUN SENSORS (4) AND EARTH SENSORS (2)
- A DEDICATED BOOM FOR S-BAND ANTENNA
- A **1.0** METER FIXED BOOM FOR EXPERIMENT
- AERODYNAMIC TAIL (ONLY FOR ATMOSPHERIC MISSION)

## TSS-S ELECTRODYNAMIC CONFIGURATION



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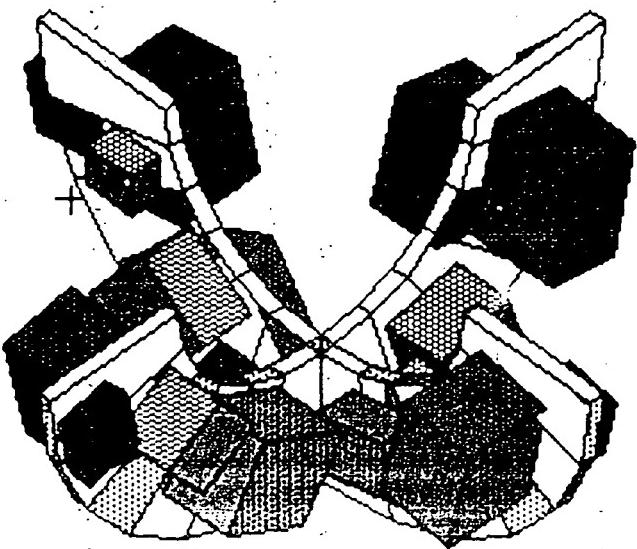
## TSS-S EXPLODED VIEW



ELECTRODYNAMIC SATELLITE INTERNAL LAY-OUT

- A) MERIDIONAL PANELS (4) AND EQUATORIAL FLOOR USED FOR SERVICE MODULE LAY-OUT
- B) PAYLOAD FLOOR; SHEAR AND POLAR PANELS, FIXED BOOM USED FOR PAYLOAD MODULE LAY-OUT
- C) EQUATORIAL FLOOR USED FOR AUXILIARY PROPULSION MODULE

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3-10-85	AERITALIA - GSS - SYSTEMS ENGINEERING
	(1) SERVICE MODULE

TSS SATELLITE SCIENCE ACCOMODATION (EDY MISSION)

GEOMETRICAL AND MECHANICAL CAPABILITIES

SCIENCE INSTRUMENTS CAN BE ACCOMODATED ON:

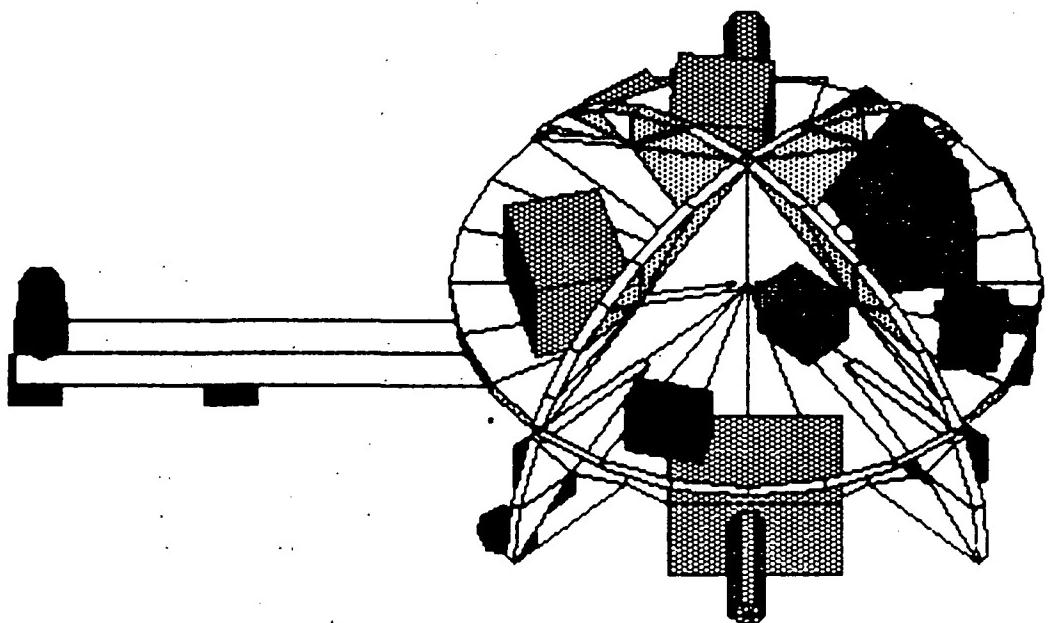
A) EITHER SIDE OF THE FOLLOWING PAYLOAD MODULE ELEMENTS:

- PAYLOAD FLOOR
- FOUR (4) POLAR PANELS
- FOUR (4) SHEAR PANELS, INTERPOSED BETWEEN THE PAYLOAD FLOOR AND THE EQUATORIAL FLOOR.

WITH:  
- TOTAL FOOTPRINT AREA AVAILABLE:  $2.4 \text{ M}^2$   
- TOTAL VOLUME AVAILABLE:  $0.4 \text{ M}^3$   
- TOTAL MASS: 66 Kg

B) THE FIXED 1.0 M LONG BOOM WITH 2 Kg TOTAL MASS CAPABILITY

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Space = 3000	3-10-85	AERITALIA - GSS - SYSTEMS ENGINEERING
		(3) PL/M AT LAUNCH

## SCIENCE FOR THE FIRST TSS ELECTRODYNAMIC MISSION

### SCIENTIFIC OBJECTIVES

- STUDY OF ELECTRODYNAMIC INTERACTION BETWEEN THE TSS AND AMBIENT PLASMA
- STUDY OF DYNAMICAL FORCES ACTING ON THE TETHERED SATELLITE

### SATELLITE INSTRUMENTATION

- RESEARCH ON ELECTRODYNAMIC TETHER EFFECTS (RETE) - PROF. M. DOBROWOLNY  
CNR/IFSI - FRASCATI - ROME
- WAVE SENSORS ON TWO EXTENDABLE BOOMS (4 m EACH) TO EXPLORE SPACE  
CHARGE REGION AROUND SATELLITE.
- TETHER MAGNETIC FIELD MEASUREMENT (TEMAG) - PROF. F. MARIANI - 2ND  
UNIVERSITY OF ROME - TOR VERGATA - ROME
- TWO MAGNETOMETERS ON FIXED BOOM (85 cm) TO MEASURE MAGNETIC FIELD AND  
DYNAMICS OF TETHERED SATELLITE.
- RESEARCH ON ORBITAL PLASMA - ELECTRODYNAMICS (ROPE) - DR. N. STONE - NASA/MSFC  
HUNTSVILLE - ALABAMA
- PARTICLE SENSORS ON FIXED BOOM (85 cm) AND ON SATELLITE TO STUDY SATELLITE  
PLASMA INTERACTION.

## SCIENCE FOR THE FIRST TSS ELECTRODYNAMIC MISSION (CONT'D)

### DEPLOYER INSTRUMENTATION

SHUTTLE ELECTRODYNAMIC TETHER SYSTEM (SETS) - PROF. P. BANKS - STANFORD UNIVERSITY - STANFORD - CALIFORNIA

VARIOUS INSTRUMENTS TO STUDY TETHER CURRENT - VOLTAGE CHARACTERISTICS, CHARGE CONTROL AND EMISSION AT ORBITER, OTHER PLASMA AND IONOSPHERIC PROCESSES.

### THEORY AND GROUND - BASED OBSERVATIONS

THEORY AND MODELING IN SUPPORT OF TETHER - PROF. K. PAPADOPOULOS - SCIENCE APPLICATIONS, INC. - MCLEAN - VIRGINIA

INVESTIGATION ON TSS DYNAMICS - PROF. S. BERGAMASCHI - UNIVERSITY OF PADOVA PADOVA

INVESTIGATION AND MEASUREMENT OF DYNAMIC NOISE IN TSS - DR. G. GULLAHORN - SAO CAMBRIDGE - MASSACHUSETTS

DETECTION OF ELECTRODYNAMIC ULF/ELF EMISSIONS BY THE TETHER - PROF. G. TACCONI UNIVERSITY OF GENOA - GENOA

INVESTIGATION OF ELECTRODYNAMIC EMISSIONS BY THE TETHER - DR. R. ESTES - SAO CAMBRIDGE MASSACHUSETTS.

ITALY IS RESPONSIBLE FOR THE INTEGRATION OF THE SCIENTIFIC INSTRUMENTATION ON THE SATELLITE

TSS CORE EQUIPMENT  
TETHER CURRENT-VOLTAGE CONTROL (TCVC) SYSTEM

PURPOSE

FOR THE ELECTRODYNAMIC MISSIONS THE TCVC SYSTEM WILL SPECIFICALLY ALLOW INVESTIGATION OF THE TSS'S ELECTRICAL POTENTIAL BY CONTROLLING THE CURRENT THAT FLOWS BETWEEN THE SATELLITE AND THE ORBITER THROUGH THE TETHER AS A RESULT OF THE EMF GENERATED (UP TO 5 KV) BY MOTION OF THE TSS THROUGH THE GEOMAGNETIC FIELD  
THIS FUNCTION IS FUNDAMENTAL TO THE OPERATION OF THE ELECTRODYNAMIC TETHER AND IS ESSENTIAL FOR THE TSS SCIENTIFIC INVESTIGATIONS.

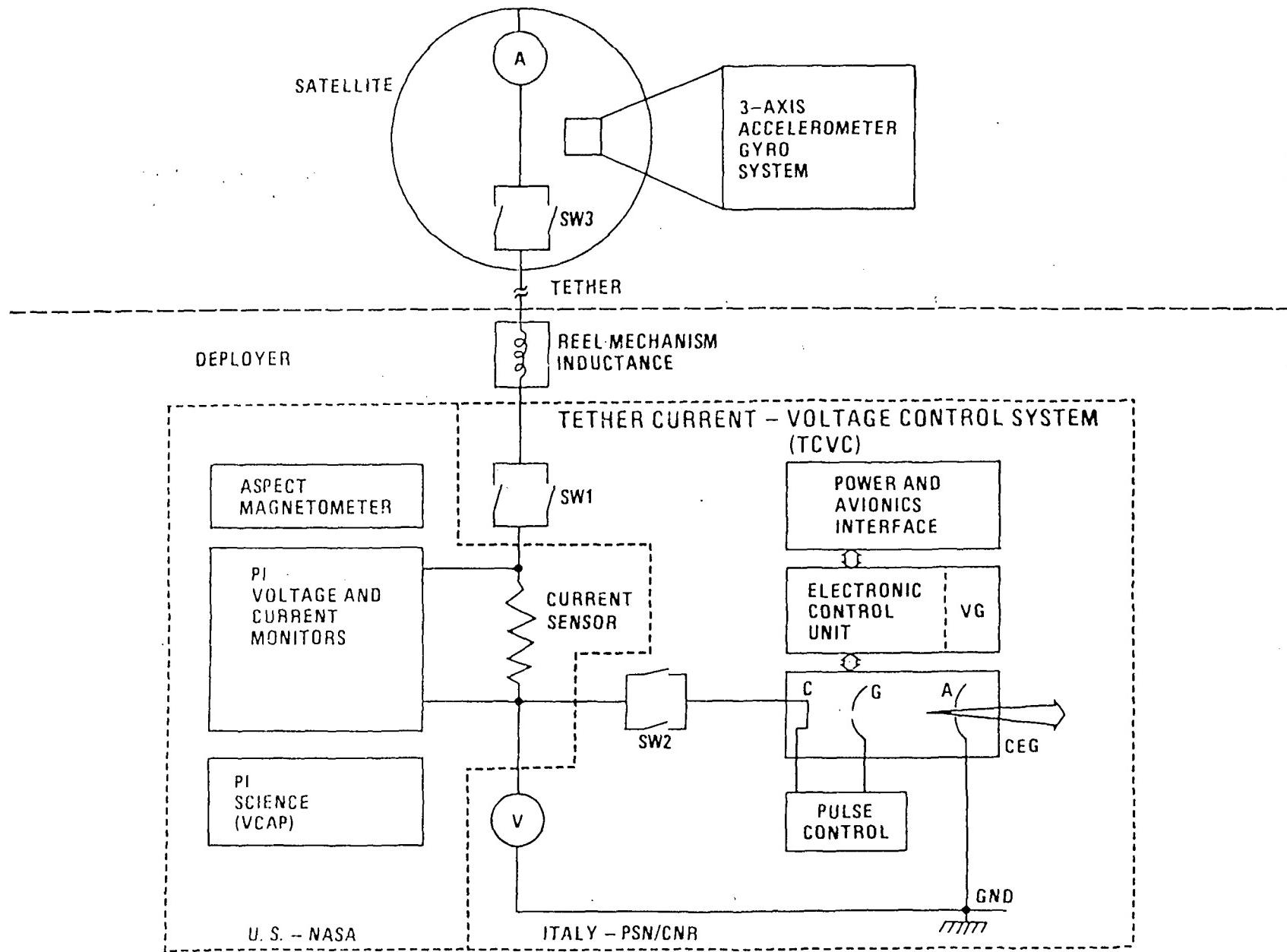
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THREE-AXIS ACCELEROMETER-GYRO SYSTEM

PURPOSE

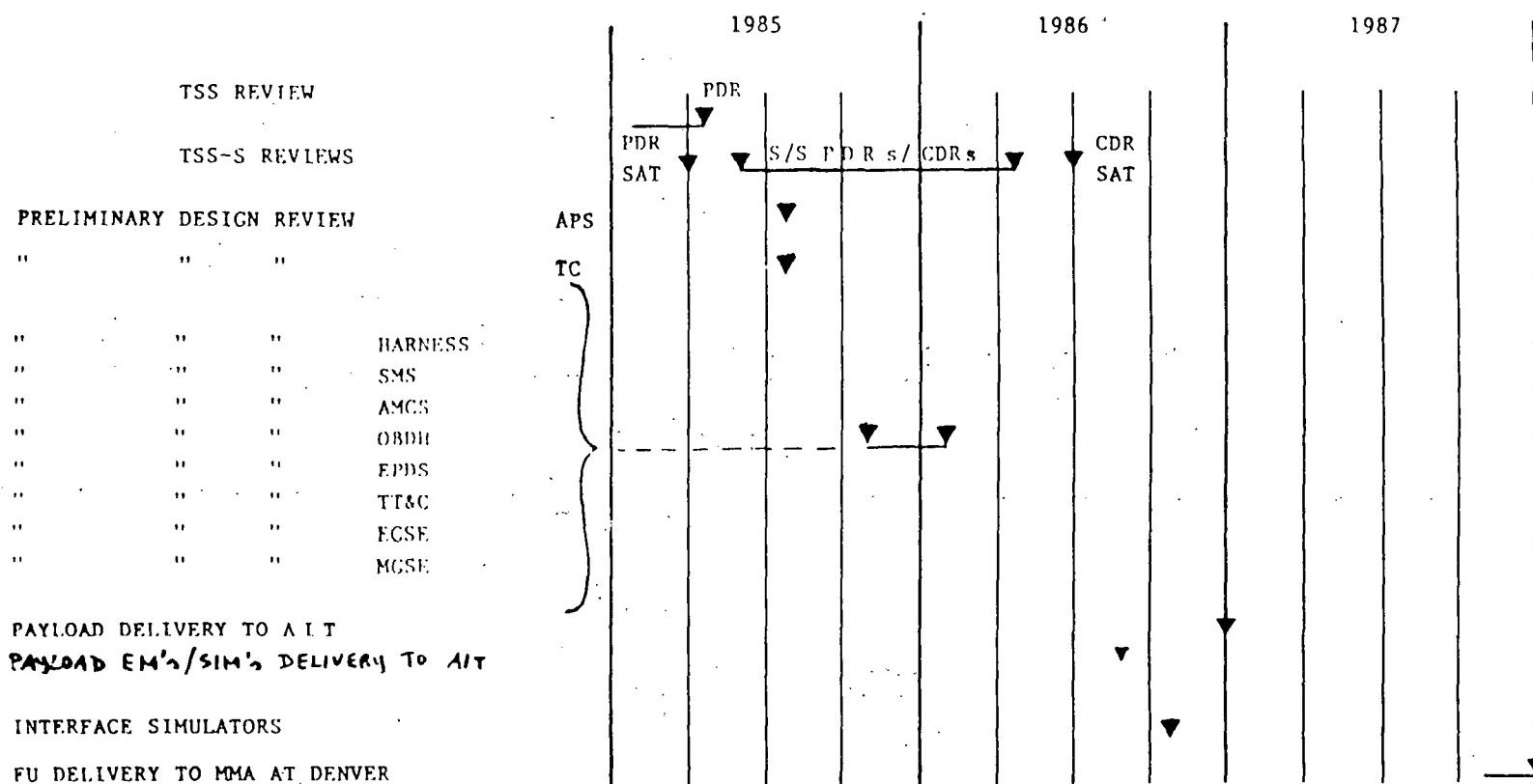
THE THREE-AXIS ACCELEROMETER-GYRO SYSTEM WILL PROVIDE A HIGHLY ACCURATE ASSESSMENT OF DYNAMIC PERTURBATION TO THE MOTION OF THE TETHERED SATELLITE.  
THIS INFORMATION IS REQUIRED TO DETERMINE THE SUITABILITY OF THE TETHERED SATELLITE AS A PLATFORM FOR A VARIETY OF INVESTIGATIONS OF CRUSTAL - INDUCED MAGNETIC AND GRAVITATIONAL EFFECTS.

TSS CORE EQUIPMENT  
(FIRST MISSION)



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## SATELLITE SCHEDULE (MILESTONE)



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